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Public Acceptance and Preference Towards Rainwater Harvesting in Klang Valley, Malaysia

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Abstract

This study explored the public acceptance and preference towards rainwater harvesting (RWH) in the area of Klang Valley. Self-administered questionnaires were used to obtain data from 109 respondents. An interview was also conducted on an individual representing a household with a RWH system. Respondents generally accepted that rainwater could be collected and reused for non-potable uses such as washing the porch and vehicles and watering the garden. While suggested WTP values of non-owners of the system fall below RM500, actual interview showed a homeowner spending a much higher amount for the system's installation. Among the attributes of a RWH system preferred by respondents were affordability, safety and convenience. Added feature of a system preferred would be having a unit subsidized by the government. These findings may assist policymakers in finding ways to promote the development and use of RWH systems in the country.

Keywords: rainwater harvesting; preference; acceptance, willingness to pay

1. Introduction

There has been a growing interest in rainwater harvesting (RWH) throughout the world to match the increase in water consumption due to rapid urbanization, population growth and climate change. RWH is one of the most promising alternative water sources, since rainwater can easily be collected and easily treated for non-potable use. Harvested rainwater for residential begins with collection, storage, and distributing the rainwater from the roof to be used inside or outside home.

Harvested rainwater is a valuable resource providing numerous benefits. RWH can be considered as a feasible solution to mitigate future climate change impacts on combined sewer overflow and supply water demands (Tavakol-Davani et al., 2016). Rainwater tanks are typically applied at the household scale for non-potable water source uses such as toilet flushing and garden irrigation as well as it could also be treated for potable use in urban areas (Cook et al., 2013; Gao et al., in-press) and rural communities

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(Opare, 2011). In many cases farm level rainwater harvesting was highly effective for rain fed farming and had a multiplier effect on farm income and help to reduce poverty (Zingiro et al., 2014; Kumar et al., 2016).

In Malaysia, RWH is slowly being introduced through local regulations that encourage the installation of rainwater harvesting system in new buildings. The 1999 'Guidelines for Installing a Rainwater Collection and Utilization System' was introduced following the 1998 drought with the aim at reducing the dependence on treated water and it could be considered as the initial phase of the rainwater harvesting policy in Malaysia (Mohd-Shawahid et al., 2007). It is anticipated that rainwater harvesting is going to play the role as an alternative water resource in the country and this means that inter-ministerial and multi-stakeholders co-operations are needed to realize the potential of these alternative water resource (Lee et al., 2016).

Unlike some other countries, RWH is not a common practice in Malaysia despite the country being endowed with abundance of rain during certain months of the year. On March 27, 2006, The Prime Minister announced that rainwater harvesting would be mandatory to large buildings (Mohd-Shawahid et al., 2007) and the National Water Resources Council (NWRC) was also launched (Darus, 2009). There might be potential problems and constrains faced by the users of a RWH system while integrating them as a part of water supply system to be used in homes. A successful implementation of rainwater harvesting policy requires the cooperation from all parties in the society. The government and relevant stakeholders needs to understand better the RWH system from the perspective of the country's citizens in order to make the technology better suited to its environment and its people (Sanidas, 2014). Understanding the acceptance and preference of the general public for a RWH system will help guide policymakers and relevant stakeholders in designing and promoting the sustainable and practical use of a RWH system in residential areas. Hence, public perception is important because it reflects the public concerns, beliefs, and values on the issue of RWH.

This study aims to investigate the level of public acceptance and preference on residential RWH system, as this system is not well applied yet in Malaysia as compared to some other countries. The respondents' opinion on their willingness to pay (WTP) for a domestic RWH system and on the system's attributes such as tank type and size, location of tank and types of water pressure are then analysed.

2. Literature Review

Much of the literature on RWH focuses on design and structures while other topics of interest include health risks and benefits of RWH, technology, storage capacity, application of RWH in various countries and factors influencing the use of RWH. In capturing rainfall effectively, many countries have worked on designing rainwater harvesting structures for different rainfall profile, rainfall regions and soil types, effective storage of harvested water and methods for its efficient use. An optimization model to determine the optimal rainwater storage tank was proposed by Okoye et al. (2015) based on rainfall profile, roof area of a building, water consumption per capita and cost of building the rainwater tank. Meanwhile Sturm et al. (2009) examined two small-scale of RWH systems which were roof catchments and ground catchments. Results indicated that it was economically feasible to apply decentral techniques of RWH is terms of the roof catchment systems while the ground catchment system needs moderate subsidies to obtain the same benchmark. The technical and economic issues in designing domestic RWH systems, evaluating its technical feasibility and economic viability have also been examined by Silva et al. (2015).

A RWH system provides a source of good quality water and the system can range in size from a simple water tank to a complicated design and built system. It provides an economically sustainable solution and supplying families with a consistent supply of water. Hence, it is important to adequately and regularly maintain rainwater tanks because improper maintenance of rainwater tanks can lead to health risks affecting individual users and the general public through the spread of water borne disease and potentially costly health impacts (Mankad et al., 2014). This is also supported by Moglia et al. (2016) through the discussion of the risk of RWH in becoming a breeding ground for mosquitoes.

Because rainwater can be contaminated by pollutants in the atmosphere and on catchment area, appropriate treatment of collected rainwater would be necessary to make the harvested rainwater safe for not only for non-potable but also potable use. While the quality of rooftop rainwater as an alternative source of drinking water is not suitable (Meera & Ahammed, 2006), appropriate effective rainwater treatment is necessary to increase the quality of harvested rainwater. Vieira et al. (2013) examined the filtration of particles in raw rainwater with no energy usage, self-cleaning mechanism, and simple installation and operation in buildings. The study indicated that the system designed under the proposed concept operated effectively with the correct selection of the filter medium suggesting that the proposed rainwater treatment concept offers an opportunity to enhance water security.

Studies were also conducted on factors influencing acceptance and preference associated with alternative water sources. Fielding et al. (2015) investigated how people's perceptions of alternative water sources differ with their perceptions of other technologies and identified significant predictors of comfort with different alternative water sources. Results indicated that participants were significantly more comfortable with drinking recycled water than they were with nuclear energy, or with using genetically modified plants and animals for food. Demographic variables were found to be less important predictors of comfort with alternative water sources than were psychological variables. Public acceptance for storm water was found to be higher than for other types of alternative water such as recycled water and rainwater (Mankad et al. 2015). Ryan et al. (2009) found that gender, age and education could not differentiate residents who were irrigating their garden with water from a tank from residents who were not. However, the study indicates that female participants and lower income residents were more likely to use greywater on their garden.

The information on the acceptance and preference levels on RWH for residential housing can be used to assist the relevant parties such as the government and private suppliers of the system to promote its use. While much of the literature on RWH focuses on its health risks and benefits, technology, design and structure, storage capacity and rainwater treatment, the perception and acceptance of RWH among the public particularly in Malaysia is one of the least explored area. Hence, this paper extends the literature by focusing on public acceptance and preference towards RWH focusing in the area of Klang Valley, Malaysia.

3. Study Methodology

This study takes the form of an exploratory approach in the attempt to understand the public's acceptance and preference for RWH. Thus, the methodology involves a quantitative analysis at the most basic form, that is the directing reporting and descriptive analysis of data obtained for the study.

The study took place during the month of December in 2015. Data was gathered through a survey on 109 adult respondents in several housing and shopping areas in Klang Valley. A questionnaire was used as the instrument for collecting data. Respondents were randomly chosen based on convenience sampling and were asked to fill in the questionnaires. The questionnaire was divided into two parts. The first part focused on public acceptance on the use of residential RWH system and the second part investigated on the preference of respondents for such system.

Apart from the survey, the study also involves an interview. Only one person representing the household was interviewed as this study is considered to be in the pilot testing stage. The person was interviewed on the costing of a RWH system already put in place in his housing area.

4. Result and Discussion

4.1. Profile of the Respondents

Respondent profile analysis of the data indicates that out of the 109 respondents, 68.8% of the respondents were male and the remaining 31.2% were female. Most of them were Malays (94.5%) and the other 5.5% of respondents were non-Malays. In terms of education, 78.9% of them had certificates from universities while 14.7% of them had secondary level education. 61.5% of respondents earned an income of less than RM2000 while 31.2% earned between RM2000 and RM3000. Most of the respondents lived in terrace houses (57.8%) followed by condominiums or apartments (14.7%). Most of the respondents (78.9%) have earned university education. Respondents reported living in areas in Kuala Lumpur, Wangsa Maju, Petaling Jaya, Kajang, Klang, Cheras and Putrajaya (Figure 1).

Fig 1. Number of respondents and areas of their residency

4.2. Acceptance Towards RWH

From the total of 109 respondents who answered the survey questionnaire, 66% of the respondents reported collecting rainwater while the remaining 44% reported not collecting rainwater at their homes (table 1). This means that a big portion of the respondents found rainwater to be useful for household chores as they were already collecting rainwater. When inquired on why respondents collect rainwater, the majority of them reported that ‘my home is plumbed for rainwater collection’. From all respondents, 81.7% have the knowledge about rainwater harvesting while only 18.3% did not know that rainwater can be collected. This shows that people within the Klang Valley area are aware of this suggested alternative way to save water.

It is interesting to note from Table 1 that 36.7% of the respondents felt that ‘it is possible to collect rainwater’ while 30.3% thought that ‘it is good to collect rainwater.’ From these findings, it shows that most of the respondents have positive perception towards rainwater harvesting, justifying positive acceptance level of the use of this system in residential areas. The pushing factor for these findings could be the abundance of rainfall in Malaysia throughout the year, making the idea of collecting rainwater possible and sustainable.

Table 1. Knowledge and acceptance on rainwater collection for residential areas

Question	Response	Frequency	Valid %
Do you know that rainwater can be collected?	Yes	89	81.7
	No	20	18.3
Do you collect rainwater?	Yes	66	60.6
	No	43	39.4
What do you think about rainwater harvesting?	I have never heard of it	11	11.9
	I think it is possible to collect rainwater	34	36.7
	I do not think rainwater needs to be collected	14	12.8
	I think it is good to collect rainwater	28	30.3
	There is no point in collecting rainwater	13	7.3

If the government wishes to increase the awareness on rainwater harvesting, there is a need to know what factors can lead and encourage people to start collecting rainwater. Table 2 presents the potential and current use of rainwater in homes as reported by the respondents. The study showed that almost all of respondents (95.4%) found collected rainwater useful for gardening, 77.1% found it useful for cleaning the porch, 73.4% for cleaning vehicles and 58.7% for flushing toilets.

Table 2. Perceived and current benefits of rainwater collected around the house

Item	Frequency	% of all respondents
Watering garden	88	80.73
Washing vehicles	68	62.39
Cleaning porch	71	65.14
Flushing toilet	54	49.54
Drinking (after boiling)	18	16.51
Washing dishes	18	16.51
Washing clothes	12	11.01
Bathing	9	8.26
Bathing pets	9	8.26
Washing toilet	9	8.26
Filling a swimming pool	6	5.50

Only 16.51% of the respondents felt that rainwater should be used for washing dishes or drinking (after boiling), 11.01% for washing clothes and 9% for bathing. The level of acceptance for the use of rainwater for these purposes are relatively low compared to the previously mentioned purposes such as watering the garden. This is probably due to health concerns from the consumption of untreated water for humans. The use of rainwater for washing of toilets also scored low in terms of acceptance (8.26%). Toilets and bathrooms around the house which normally are not located close to the garden, porch or corridor where a RWH system could be placed could be the reason for this as rainwater needs to be carried (channelled) into the house to perform this purpose.

In the survey questionnaire, the respondents who during the time of survey did not collect rainwater were asked on the amount of money they would be willing to pay in order to install a RWH system at their house. Willingness to pay (WTP) refers to the maximum amount of money an individual is willing to spend to procure a good or avoid something undesirable. 38.5% (42 respondents) were WTP between RM50 to RM100 and 18.3% (20 respondents) were WTP between RM101 to RM500. The remaining respondents did not attempt to answer this question.

Respondents were asked to respond to the statement ‘I will consider installing a rainwater collection unit within my housing compound if...’. A number of subsequent statements were posed and respondents were to select from a 5 point Likert scale answer from 5 (most agree) to 1 (least agree). All of the statements’ responses illustrate respondents’ positive preference towards the RWH (Table 3) .

Table 3. Factors respondents consider inportant when deciding on installation of RWH systems at their houses

Statement	Mean	Std. Deviation
If there is water rationing / interruption of water supply	4.55	0.928
It would save my water bills	4.32	0.792
It would help to conserve water (reduce dependence on pipe water)	4.31	0.742
It is convenient to use the water collected	4.09	1.093
We were having or expecting a drought	4.06	0.905
I had to install it under new policy or regulation	4.06	0.955
My lawn/porch was bigger in size	4.02	1.202
Installment cost is within my household budget	4.03	1.004
Tank size does not use up much space	3.94	1.124
Maintenance cost is low	3.94	0.901
It is easy to install	3.81	0.833
I was given a grant/ subsidy by the government to install it	3.81	1.014
I have seen somebody in my housing area using it	2.72	1.546

The factors that respondents considered high in priority in deciding whether or not to install a RWH system include ‘if there is water rationing’ or ‘if we are having or expecting a drought’, ‘if it would save water bills’, and if ‘it would help to reduce dependence of pipe water’. This reflects that the public associates rainwater collection with interruption of tap water supply. Thus, as long as the public believes that the tap water supplied to them is aplenty, they may not consider collecting and reusing rainwater. Respondents answers on water bills and water supply usage however indicates that they might consider using the RWH system if it could substantially reduce their dependence on tap water. In the questionnaire, when inquired on the monthly water bill of the household, about 70.6% of the respondents reported monthly water bill of RM50 and below and 32% between RM100 to RM300.

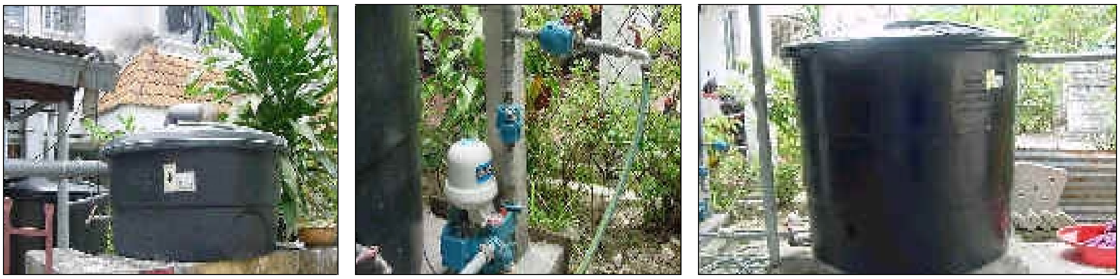
Respondents were also likely to install a RWH system if its installation were made compulsory through a policy. Other weaker factors determining the acceptance of a RWH system includes lawn or porch size, installment cost, space taken by the water tank, ease of maintenance and ease of installation. Grant by the government surprisingly not high on the priority list of installing a RWH system. This shows that the RWH concept is one that is feasible to implement as the public is already beginning to accept the role of rainwater to complement and reduce the dependence of the more costly treated tap water in performing related household chores.

Apart from the survey, an interview was conducted on a resident in Taman Melawati, Kuala Lumpur. Almost 80% of houses in this area have installed RWH systems since 2001. The interviewee (Mr. Nordin) can be regarded as the representative of the households in this area as they have installed a similar type of RWH system as the interviewee.

The short interview session conducted during December 2015 only involved an inquiry on the installation cost of the RWH system placed at a double-storey terrace house since 2001. The total amount spent on the the installation of the whole system was RM2,700. It includes two 2,500 liter capacity water tank placed on the ground costing RM1,000 in total and an elevated tank unit costing RM200. An electrical water pump was installed costing RM750. Plumbing works, a conveyance system and PVC gutter were installed costing RM400, RM200 and RM150 respectively (Table 4). Figure 2 illustrates the outdoor RWH system placed at Mr Nordin's house.

Table 4. Installation cost for RWH system at a double-storey terrace house in Kuala Lumpur in 2001

Item	Amount (RM)
Gutter (uPVC)	150
Conveyance system	200
Plumbing works	400
1 unit water tank (elevated)	200
2 units water tank (ground) 2500 litres capacity	1000
Water pump (electrical)	750
Total cost	2700



(a) (b) (c)

Fig 2. A RWH system in a double-storey housing compound in Taman Melawati, Kuala Lumpur: (a) an elevated water tank (b) the water pump and outlet tap (c) ground water tank

4.3. Public Preference

The respondents' preference for a residential RWH system was gauged through questions related to the physical attributes of the system as well as other attributes (Table 5). Respondents preferred the use of drums instead of house water storage tanks. This is possibly due to the size of water drums which are smaller than house water tanks. Smaller size could mean less space taken and less physical presence seen which reduces loss of aesthetic beauty of outdoor house surrounding. Respondents also preferred stainless steel tanks and fiber glass tanks over concrete or ceramic ones.

72% of respondents preferred water tanks to be placed on roof tops rather than on the ground or underground. 90% of respondents preferred an elevated system which allowed a medium level of water pressure to be available without the need for electrical water pumps.

Table 5: Attributes of a RWH system and preference of respondents

Preferred attributes		Frequency	Valid %
Tank size	drum (100 - 250 litres)	92	84.4
	house water storage tank (> 250 litres)	17	15.6
Type of tank	Stainless steel	56	51.4
	Concrete	0	0
	Ceramic	0	0
	Fiber glass	53	48.6
Water pressure from tank	Low (no pump)	18	16.5
	Medium (elevated tank)	90	82.6
	High (electric pump)	1	0.9
Location of tank	On the ground	18	16.5
	Under ground	19	17.4
	Top of roof	72	66.1
Other attributes	If the system has auto-cleaning mechanism	91	83.5
	If the system is cheap and convenient	90	82.6
	If the system is subsidies by government	90	82.6
	If the system is safe for the children	89	81.7
	If the system is not bulky	89	81.7

Other attributes of a RWH system which were of concern to respondents were related to convenience, safety and affordability. Respondents preferred a RWH system that has auto-cleaning and safety mechanisms. The system should also be easy to use, not bulky and affordable. Affordability can be enhanced through a subsidy by the government.

5. Conclusion and Practical Applications

An increasing number of population will soon increase the demand for water consumption. Although the sources of water supply remain available, it would not last much longer for the future generation. Therefore, proactive measures must be taken to avoid acute water shortages in the future. Conservation and finding other alternative sources of water supply need to be done urgently. Rainwater harvesting which offers a lot of benefits not just for the users, but also to the government and environment, is a suitable alternative that could minimise the anticipated water supply crisis.

A RWH system can be a simple and inexpensive system consisting of a downpour pipe and a container or it can be an expensive and complex one with water pressure control mechanism, underground storage and indoor piping system. If the government could prove that RWH systems would save people's water usage at their homes and if the government can assist in providing each house in newly-built residential area with a RWH system at reasonable price to exercise the rainwater collection, in time people will acknowledge this alternative sources of water supply as foreign countries residents do.

The first objective of this study is to examine people acceptance and preference about rainwater harvesting and it has pointed to the fact that the public are knowledgeable about rainwater harvesting but some unfortunately, still did not want to take any action. Although their preferences vary with each other, the underlying reason for them to install rainwater harvesting remains the same that is if only it can reduce their household water bill. Apart from that, they also recommended that the government provides subsidies and make necessary adjustment on the requirement for installation of RWH system on newly-built houses such as minimal fees on monthly as well as annual maintenances.

Generally, people tend to distant themselves from using rainwater even for potable usage. This is partly due to the lack of evidence that rainwater is free from any harmful substance collected from rooftops. As for non-potable uses, the collection and reuse of rainwater needs to be encouraged. In times of drought and occurrences of waterpipe breakdown or water supply contamination, tap water supply is disrupted and the public needs to turn to rainwater for substitute. Given that the public knew that rainwater can be used for flushing toilets, watering garden, washing porch and washing vehicles, it would be most appropriate if a study on the actual physical and perceived composition of collected rainwater could be done. This suggested research would be an effort towards gaining people's confidence and attracting people to install RWH system in their homes not only for non-potable usage but also for potable usage.

Nevertheless, it is important to stress that cost does play a vital role in determining the willingness to install a RWH system. Some people who care about environmental issues were slightly different from others as they would be willing to pay if that could help to conserve water as a precious natural resource and reduce water pollution. In this study, unfortunately, their willingness to pay are low and limited as they also prefer for the government to subsidise the installation of RWH system. The respondents however agreed to install the system if it can increase productivity and reduces their water bill and they also agreed that by utilizing rainwater, water crisis can be minimized.

Any successful implementation of a RWH system would greatly contribute to sustainable development in Malaysia. The rainwater harvesting approach has fulfilled the needs of the people demand for water supply in certain residential areas such as Taman Melawati Wangsa Maju and Ken Rimba Shah Alam. They are using rainwater for non-potable uses such as for washing vehicles and flushing toilets. The importance of rainwater harvesting system as an alternative water supply only can be seen if water rationing continues, such as in Sandakan, Sabah. People who have already built the system found it reasonably priced and suitable for their needs. The system has become a part of the housing scheme at the newly-built residential housing in certain areas such as in Maluri, Cheras. By using rainwater, households could minimize the use of treated water for non-potable uses. This situation shows that a lot of saving can be done by using rainwater. In addition, to make saving more prominent, the government should make a legal requirement for the installation of a centralized rainwater system for all residential areas.

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